UNITED STATES GENERAL ACCOUNTING OFFICE

REPORT TO THE CONGRESS

Aircraft Midair Collisions: A Continuing Problem B-164497(1)

Department of Transportation

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

OCT. 23, 1974

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-164497(1)

To the Speaker of the House of Representatives
and the President pro tempore of the Senate

This is our report entitled "Aircraft Midair Collisions: A Continuing Problem."

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Transportation; the Administrator, Federal Aviation Administration; and the Secretaries of Defense, Army, Navy, and Air Force.

Elmer B. Staats
Comptroller General
of the United States

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ABBREVIATIONS

AAC	Aviation Advisory Commission
ATA	Air Transport Association
ATCAC	Air Traffic Control Advisory Committee
ATCRBS	Air Traffic Control Radar Beacon System
AVOIDS	Avionic Observation of Intruder Danger Systems
CAS	collision avoidance system
DABS	Discrete Address Beacon System
EROS	Eliminate Range Zero System
FAA	Federal Aviation Administration
GAO	General Accounting Office
IFR	instrument flight rules
IPC	Intermittent Positive Control
PWI	proximity warning indicator
SECANT	Separation Control of Aircraft by Nonsynchronous Techniques
TAU	time to collision
VECAS	Vertical Escape Collision Avoidance System
VFR	visual flight rules

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

AIRCRAFT MIDAIR COLLISIONS: A CONTINUING PROBLEM
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D I G E S T

WHY THE REVIEW WAS MADE

GAO wanted to know how technological developments were being used by the Federal Aviation Administration (FAA)--responsible for promoting and regulating safe aviation in the United States--to find solutions to the midair collision problem.

FINDINGS AND CONCLUSIONS

FAA has been studying the midair collision problem for almost two decades. Meanwhile, the civil aviation midair collision problem persists despite improvements in the Nation's air traffic control system.

While midair collision fatalities in recent years have constituted only about 5 percent of the overall civil air transportation deaths, the advent of the jumbo jets could drastically change the situation. A collision between two of these aircraft could be catastrophic. Collisions involving the more numerous other commercial and general aviation aircraft are also costly.

The present air traffic control system has separation responsibility only for aircraft under its control. Generally, controlled aircraft are airliners and other high-performance planes operating under instrument flight rules and uncontrolled aircraft are generally aviation planes flying under visual flight rules.

In a recent study of 271 midair collisions, only two were noted when the ground-based air traffic control system had responsibility. Although this indicated that the ground-control, or instrument flight rules, system worked effectively to prevent collisions between controlled aircraft, less than 30 percent of the planes flying over the United States are under ground control.

Virtually all the collisions occurred when the air traffic control system did not have separation responsibility because only one or neither aircraft was under its control. At least one general aviation aircraft was involved in all but two collisions. (See pp. 2 and 3.)

Developing of technologies for solving the problem has progressed but has been hindered by

--differences in technical opinion,

--changes in the level of interest and funding by FAA,

--need for analysis, and

--FAA's commitment to ground-controlled solutions.

Numerous solutions have been proposed, but none are ready for nationwide implementation. In view of the time needed to implement technology, a useful solution would not be available for about a decade. Several more years would be needed to complete implementation.

Solutions proposed fall into two broad categories: ground-controlled and airborne. Ground-controlled solutions rely on providing new performance capabilities for the present air traffic control system. These solutions require developing of new airborne equipment to provide the interface necessary between ground control and aircraft. (See p. 3.)

Airborne solutions generally operate independently of the air traffic control system. They depend on new aircraft equipment, which provides pilots automatically with maneuvers or warns them of nearby aircraft. (See p. 3.)

The Congress has been attempting to accelerate FAA's collision avoidance efforts, primarily with an airborne solution. Pending legislation (S. 1610 and H.R. 7125, 93d Cong., 1st Sess. (1973)) calls for national airborne equipment standards before July 1975 and for airliners to be equipped before July 1977. (See p. 11.)

However, FAA evaluations of competing equipment will not be completed at least until mid-1975 and the first production units will not be available before mid-1977. FAA's current program cannot meet the target dates stipulated in the pending legislation. (See p. 12.)

FAA is committed to the premise that, for the foreseeable future, the ground-based air traffic control system will be the primary collision avoidance system. FAA's approach is being pursued without comprehensive analyses of alternative solutions. (See pp. 4 and 5.) Moreover, it rests on an advisory committee's 1969 recommendations, which have since been questioned by another independent commission. The committee favored a ground-based solution, and the commission favored an airborne solution.

Compounding this controversy, both minority positions cited the lack of analyses and justifications in arriving at conclusions and recommendations. (See pp. 7 through 9.)

Implementation of any ground-controlled or airborne system will be costly for all. FAA has only recently started comparing costs of independent airborne systems with costs of ground-controlled systems. However, FAA has not decided how many ground sites will be required if the ground solution is selected. Cost figures will vary according to the number of sites finally decided upon. (See pp. 19 and 20.)

Because of the human and monetary cost potential of future accidents, controversy over which solution is best, and large investment necessary to implement any solution, FAA must take early action.

It will have to validate its approach through a comprehensive analysis. This analysis should include a determination of what airspace and types of aircraft are to be covered and total costs for implementing alternative solutions, both airborne and ground controlled, to provide the necessary coverage. (See p. 22.)

If this is not done, there will be no assurance that the FAA's approach is the proper one. Further, the course selected must be revalidated periodically as more information on cost and technical progress is obtained. Without this action, the midair collision problem and the current controversy will continue.

RECOMMENDATIONS

The Secretary of Transportation should require and oversee an FAA analysis of all alternative solutions to the midair collision problem.

The analysis should be directed toward showing whether a solution is economically feasible, and, if so, which alternative--upgraded ground control with collision avoidance equipment, airborne equipment, or a combination of these--offers the best approach. It should address, but not be limited to, the following issues.

--Defining the airspace which requires coverage and the most cost-effective level of coverage for each alternative.

--Identifying the costs, both public and private, to acquire, implement, operate, and maintain equipment and sites for each alternative.

--Identifying the approaches and cost impact for equipping military aircraft under each alternative since these could collide with civil aircraft.

--Ascertaining the technological status of alternatives based on test results and the time required for full implementation.

--Verifying the technical approaches and proposed selling prices of general aviation collision avoidance units.

--Considering the effect of the energy crisis, environmental restrictions, and economic factors on the predicted growth of general aviation and subsequent impact on air traffic control needs.

The best approach should be emphasized and efforts on other alternatives should be reduced.

The approach chosen should be revalidated periodically as more current information is obtained on cost and technological progress. Further, FAA should expedite its evaluation program of general aviation airborne collision avoidance units.

AGENCY COMMENTS

The Administrator of FAA agreed fully with the recommendations (see app. III) and stated that:

--GAO's report presents a fair and reasonable assessment of the situation.

--FAA has begun an in-depth analysis of the alternate solutions to the midair collision problem and has obtained a significant amount of information concerning costs and the potential effectiveness of airborne and ground-based systems.

--The completed analysis will provide the basis for the FAA-recommended system.

--FAA is proceed with efforts and a priority consistent with GAO's recommendations.

The Department of Defense and the contractors involved in the program concurred with GAO's conclusions and recommendations.

MATTER FOR CONSIDERATION BY THE CONGRESS

We are bringing this matter to the attention of the Congress due to the large investment necessary both to the user and the Government to implement any solution and because of the Congress' continuing interest in the midair collision problem. Congressional monitoring may be needed to assure that the best solution, in terms of cost and effectiveness, is selected.

CHAPTER 1

OVERVIEW OF MIDAIR COLLISION PROBLEM AND PROPOSED SOLUTIONS

The Federal Aviation Administration (FAA) is responsible for promoting and regulating aviation safety. Midair collisions are a persistent civil aviation problem in spite of improvements in the Nation's air traffic control system and associated equipment. Civil collisions, which tend to increase with air traffic activity, increased from 114 in the 4 years ended 1967 to 157 in the 4 years ended 1971. Deaths rose from 223 to 333. In 1971 the Secretary of Transportation stated that the midair collision potential represented the most serious problem facing U. S. aviation. The continuing importance of the problem was also recognized in a 1973 report of the Aviation Advisory Commission chartered under the Airport and Airway Development Act of 1970, Public Law 91-258, to formulate recommendations concerning the long-range aviation needs. However, the effect of the energy crisis on future airline traffic and growth of general aviation may alter these needs and affect alternative solutions to the problem.

FAA emphasizes that midair collision fatalities in the above period have constituted only 5 percent of the overall civil air transportation deaths. However, the advent of the jumbo jets may dramatically change the number of deaths. A collision between two of these could result in a loss approaching 1,000 lives. Estimates show that the costs of such a collision could be between $180 million and $190 million. Collisions involving the more numerous other commercial and general aviation aircraft also add a large toll in lives. Insurance claims, aircraft replacement, and investigations add substantial monetary cost.

The present air traffic control system has separation responsibility only for aircraft under its control. "See and avoid" rules apply in all other circumstances. Generally, controlled aircraft are airliners and other high-performance planes operating under instrument flight rules (IFR) and uncontrolled aircraft are small general aviation planes flying under visual flight rules (VFR).

The following table shows the number of civil aviation midair collisions, the number of fatalities, and the type of aircraft involved during the 8 years ended 1971. Most collisions occurred close to airports, during daylight, in clear weather, at low altitudes, and at slow closure speeds.

	Between air carriers						Between general aviation and					
	Air carriers		General aviation aircraft		Military aircraft		General Aviation aircraft		Military aircraft		Yearly total	
Year	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities	Accidents	Fatalities
1964	---	---	---	---	---	---	19	9	2	3	21	12
1965	1	4	---	---	---	---	28	23	2	3	31	30
1966	---	---	---	---	---	---	32	31	1	-	33	31
1967	---	---	2	108	---	---	24	33	3	9	29	150
1968	---	---	3	5	---	---	40	57	1	5	44	67
1969	---	---	2	83	---	---	26	38	2	-	30	121
1970	---	---	---	---	---	---	36	48	5	3	41	51
1971	---	---	3	4	1	50	37	40	1	-	42	94
Total	1	4	10	200	1	50	242	279	17	23	271	[a]556

[a]About 6 percent of the fatalities resulted from collisions of planes flown intentionally close together, generally crop dusters. FAA considers such accidents nonpreventable.

GAO note: Statistics recently provided by the National Transportation Safety Board for 1972 show that there were 25 accidents, with 41 fatalities, all between general aviation aircraft, except 1 accident which was between an air carrier and general aviation aircraft. Preliminary statistics for 1973 show 24 accidents involving 29 fatalities, all between general aviation aircraft.

In a recent study of the 271 midair collisions shown above, only 2 were noted when the ground-based air traffic control system had separation responsibility. In both cases, the collisions occurred because pilots deviated from instructions. The study concluded that the ground control, or IFR, system worked effectively to prevent collisions between controlled aircraft; however, less than 30 percent of the planes flying over the United States are under ground control. Virtually all the collisions occurred when the air traffic control system did not have separation responsibility because only one or neither aircraft was under its control. At least one general aviation aircraft was involved in all but two collisions.

FAA has been studying and monitoring the problem at various levels of activity since the early 1950s. During this time, numerous solutions have been proposed, but none are ready for nationwide implementation. In view of the time needed to implement technology, a useful operational solution would not be available for about a decade and several more years would be needed to complete implementation.

The proposed solutions fall into two broad categories--ground controlled and airborne. Ground control solutions rely primarily on providing new performance capabilities for the existing system. These solutions require development and installation of new ground and airborne equipment to provide the necessary exchange of information between the ground and the aircraft. Airborne solutions, which generally operate independently of the present air traffic control system, also require new aircraft equipment, which either automatically provide pilots with evasive maneuvers or warns them of aircraft nearby.

GROUND-CONTROLLED SOLUTIONS

The primary ground-controlled solution being studied by FAA is Intermittent Positive Control (IPC), now in early development. It is a system providing collision avoidance functions which can be integrated with a future air traffic control upgrading known as the Discrete Address Beacon System (DABS). IPC will provide automatic avoidance commands from the ground to pilots based on analysis and resolution of potential collisions indicated by radar/beacon-acquired information within existing airspace coverage. To expand airspace coverage, the developers see two options. One would expand IPC through additional ground sites; the other requires developing a supplemental airborne system known as Synchro-DABS.

FAA is committed to the premise that the ground-based air traffic control system is and will continue to be the primary collision avoidance system (CAS). It believes that the separation assurance functions of this system, which pertain only to controlled aircraft, should be augmented in an evolutionary manner through increased use of regulatory measures and further extension of services to cover broader areas. FAA does not consider it feasible at this time to extend the system to control all aircraft, in view of the greatly increased requirements on radar coverage and on control personnel and in view of potential restrictive aspects to general aviation flying.

AIRBORNE SOLUTIONS

The airborne solutions being investigated by FAA fall into two categories. The first group--airborne CAS--are all-weather systems which detect aircraft, automatically evaluate the degree of threat, and provide an evasive maneuver to the pilot. The second group--proximity warning indicators (PWI), or pilot warning instruments--alert a pilot to nearby aircraft, increasing the probability of visual detection. He must evaluate the situation and decide on an evasive maneuver. Generally, airborne solutions require cooperative systems; i.e., the converging aircraft must be equipped with compatible airborne CAS or PWI.

Within the airborne CAS field, three major contractors are developing "families" of devices. (See app. I.) A family of equipments runs from a simple device transmitting a "here I am" message to a complete airborne CAS which provides maneuver commands. Each contractor is supplying two different levels of airborne CAS for FAA-sponsored flight testing. One is an expensive system for airliners and other high-performance aircraft. The other is a simplified, lower cost version for general aviation aircraft. Other contractors may submit systems for evaluation soon.

The airborne PWI field is more diverse than the airborne CAS. (See app. II.) One contractor's system has been in use by the Army on helicopters for over 3 years. Recently, the Department of Transportation's Transportation Systems Center under FAA sponsorship selected four other contractors to develop PWI hardware for testing. Various technologies are involved, such as detecting near infrared energy emitted by aircraft anticollision lights and interrogating-responding devices similar to the Army's system.

SYSTEM IMPLEMENTATION COST CONSIDERATION

Implementing any system will be costly to the user and the Government. Only an airborne solution can provide complete airspace coverage; however, FAA has not determined whether such coverage is warranted or what the cost-effective level of coverage would be. Ground-based control providing a collision avoidance function will require large investments to upgrade present air traffic control capabilities. Since the present air traffic control system services only part of the airspace and less than 30 percent of flight operations within that airspace, total costs for facilities, equipment, and land acquisition will depend partly on the extent of expansion found necessary for effective collision avoidance. Whichever approach is chosen, new equipment will be needed in the aircraft.

CHAPTER 2

EFFORTS TO SOLVE PROBLEM

Progress has been made in developing technologies for solving the midair collision avoidance problem, including increases in technological capabilities and decreases in equipment cost. However, FAA's airborne CAS efforts have involved changes in the level of interest and funding, differences in technical opinion, a commitment to ground-controlled solutions, and a need for analyses concerning the merits and trade-offs of alternative actions. Emotional aspects of the issue and forces exerted by various groups within and outside the aviation field further complicate this situation.

EARLY YEARS

In the early 1950s, radar began providing air traffic controllers an independent means of monitoring aircraft position. Following the Grand Canyon airliner midair collision in 1956 which killed 128 persons, FAA became actively engaged in airborne collision avoidance technology. Beginning in the late 1950s an interrogator-responder system, ATCRBS,1/ was added to the radar. In 1959 FAA organized the Collision Prevention Advisory Group composed of representatives of the military services and selected civil aviation associations. This group pushed the development of both airborne CAS and airborne PWI equipment.

FAA considered discontinuing its efforts in the airborne field in 1961 because of expectations that a future ground-controlled system would alleviate the problem and the poor performance of airborne systems evaluated to that time. However, in 1962, FAA decided to continue its work and awarded a contract in 1963 to investigate various CAS concepts. The final report under this contract said that an airborne time-frequency technique 2/ was the most promising method at the time but cautioned that there seemed to be little likelihood of providing general aviation aircraft with a truly effective system under the then-current state of the art.

[1] Air Traffic Control Radar Beacon System.

[2] App. I explains the time-frequency eliminate range zero system (EROS).

AIR TRANSPORT ASSOCIATION (ATA) AND TIME-FREQUENCY TECHNIQUE

Having decided that the airborne time-frequency was the way to proceed, FAA prepared to buy a system for investigation. However, in 1966 just before requesting proposals, ATA asked FAA to suspend its program and support a program ATA had advanced. By mid-1967 ATA's effort resulted in a system specification, and a year later ATA awarded a contract for evaluating several time-frequency systems. In March 1970, several time-frequency systems were considered effective, among them a McDonnell Douglas system. ATA then sought FAA's endorsement of the time-frequency system and approval for its use on aircraft. It also asked FAA to fund development and competitive production of time-frequency equipment suitable for use by general aviation aircraft.

However, other events complicated FAA's decision. The RCA Corporation and Honeywell, Inc., proposed systems within a different technology which they claimed would perform as well as, if not better than, time-frequency and could be sold at substantially lower prices. Also, a report by the Department of Transportation's Air Traffic Control Advisory Committee (ATCAC) recommended against deploying any purely airborne system and favored a ground-controlled CAS.

ATCAC REPORT

ATCAC was formed to recommend an air traffic control system for the 1980s and beyond. Its 1969 report has since served as the guide for FAA's air traffic control system improvement program. Two major traffic system philosophies were considered. The recommended one emphasized improving ground-based control; the other relied on a more distributed form of control which would place collision avoidance and most air traffic control functions in the cockpit.

ATCAC believed that the air traffic control system had largely eliminated the midair collision problem when both aircraft were under its control. However, it felt that by 1980 new measures to solve ground-based control problems would become mandatory in airspace containing both controlled and uncontrolled flights.[1] It believed this problem could be overcome by further automating and increasing the precision of the air traffic control system. However, little was said about the extent of the problem in airspace not covered by the present air traffic control system radar.

A collision avoidance function was deemed possible if the ground-based air traffic control system was upgraded. For this, ATCAC recommended IPC, a concept in which conflicts between aircraft under radar surveillance would be predicted and safe maneuvers calculated by computers. Appropriate commands would automatically be transmitted to the aircraft via a proposed two-way electronic link and displayed to the pilot.

ATCAC was concerned that airborne collision avoidance alternatives might not be compatible with the air traffic control system and that their cost could preclude widespread implementation. It stated that, if an airborne system was developed that was compatible with the air traffic control system, it would be necessary to compare the costs of implementing such a system with those for IPC or another equivalent ground system. Since that time, lower cost airborne CAS have been proposed and FAA simulations have shown no conclusive evidence that the presence of these systems adversely affected the air traffic control system efficiency. In March 1974 FAA started to compare the costs of independent airborne systems with those of IPC.

AVIATION ADVISORY COMMISSION (AAC) REPORT

Since the ATCAC report, the Aviation Advisory Commission (AAC) was established under the Aircraft and Airway Development Act of 1970, Public Law 91-258, to formulate recommendations for long-range aviation needs for the Congress and the President. In a 1973 report, AAC questioned recommendations of ATCAC for upgrading the air traffic control system. AAC favored the form of air traffic control rejected earlier by ATCAC. AAC claimed

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[1] Generally, controlled aircraft are airliners and other high-performance planes and uncontrolled aircraft are general aviation planes.

preliminary studies showed that placing certain traffic control functions in the cockpit, including collision avoidance, may be more cost effective than upgrading the ground-controlled system. According to AAC, numerous corporate and business pilots as well as the Air Line Pilots Association favored its concept over FAA's.

Compounding the controversy were the minority positions in each report which cited the lack of analyses and justifications in arriving at conclusions and recommendations. So, after two decades of effort, a basic controversy exists on how to proceed. Further, a 1973 report, prepared under FAA sponsorship to assess air traffic control system effectiveness and compare the findings with several proposed solutions for collision avoidance, noted that important trade-offs were involved but were beyond the study's scope. These included questions of implementation, technology, dollar costs, and deployment factors.

OPERATIONAL SYSTEMS

Other efforts on airborne CAS have been successful. In 1960 two McDonnell Aircraft Corporation (now McDonnell Douglas Corporation) planes collided during routine test flights. The company developed a CAS which was demonstrated to FAA in 1963 and became operational in 1965 for flight-testing McDonnell Douglas military aircraft operating out of St. Louis. In 1966 the company submitted proposals on its system to FAA and the airlines. This system, in essence, is the one the ATA has sponsored over the years.

In late 1967 the Army realized that the collision hazard was seriously affecting pilot training at its helicopter training school and that a preventive system was urgently needed. In 1968 after a competitive evaluation of several candidates, a Honeywell PWI was selected. Deliveries began in 1969 and since then, close to 300 units have been installed on helicopters. The system has worked effectively in the training school environment which has a large number of takeoffs and landings.

A 1973 Honeywell study showed that civil aviation collisions and those occurring between Army helicopters before installing PWI took place under similar conditions--during daylight, in clear weather, at slow closure speeds, and close to dense traffic areas.

To prevent collisions between a mix of low- and high-performance helicopters and fixed-wing aircraft, Honeywell, under Army contract, has developed an advanced system which approaches airborne CAS capabilities. This system is being evaluated by the Army and served as a basis for the contractor's airborne CAS.

The above shows that significant progress has been made in airborne solution technologies and their application to special operational situations in a short time. FAA believes this increases the possibility of solving the much more complex national collision problem.

CHAPTER 3

CONGRESSIONAL INTEREST AND USER COMMENTS

Over the last several years, the Congress has been attempting to accelerate FAA's efforts to resolve the mid-air collision problem. The primary thrust of the congressional effort has been toward the airborne equipment solution with pending legislation (S. 1610 and H.R. 7125, supra.) requiring the selection of an airborne CAS national standard before July 1975 and installation on airliners before July 1977.

PROPOSED LEGISLATION

The bills introduced in the Senate and the House of Representatives in April 1973 would require FAA to (1) expedite the evaluation and selection of a national standard for an airborne CAS, (2) develop plans for operating rules and regulations integrating this system into the ground-based air traffic control system, and (3) require installation of such a system on all classes of aircraft by certain dates. Flight tests and evaluations of the competing systems were to be completed by March 30, 1974, and a national standard selected by June 30, 1974. Airliners were to be equipped by June 30, 1976, and all other aircraft by June 30, 1978. (See S. 1610 and H.R. 7125, supra.) During January 1974, milestone dates in the Senate bill were amended (Amd. No. 949, 93d Cong., 2d sess. (1973)), to require completion of equipment evaluations by December 30, 1974; selection of a national standard by June 30, 1975; and equipment of airliners by June 30, 1977, and all other aircraft by June 30, 1979.

In August 1973 and June 1974 additional bills were introduced in the House which basically required FAA to accomplish the same objectives as the previously proposed legislation. (See H.R. 9758 and H.R. 15632, 93d Cong., 2d sess.) However specific dates were not set. Rather, a national airborne CAS standard would be required within 1 year after allowing a reasonable time to complete necessary flight tests and evaluations. These bills and the Senate bill 1610 amendment also would require small aircraft as a minimum to carry a device which produces a signal of its presence to other aircraft.

CONGRESSIONAL INTEREST

FAA, in hearings and correspondence, has gone on record as sharing congressional concern over the midair collision problem. In recent years FAA adopted a policy of evaluating all promising airborne CAS and PWI devices because of congressional interest and because these systems could provide a fallback position if legislation mandates an airborne CAS. As part of its expanded program, FAA's plan included objectives for setting national standards for both an airborne CAS and PWI. However, these objectives have recently been deleted from the program milestones. At best, FAA's efforts will be completed by mid-1975 and initial production units could be available by mid-1977. Consequently, FAA's evaluation program will not be completed in time to meet target dates in pending legislation.

Congressional interest has continued over the past several years. The Government Activities Subcommittee of the House Committee on Government Operations conducted hearings on January 27, 1970, on "Problems Confronting FAA in the Development of an Air Traffic Control System for the 1970s" and on August 3, 1971, on "Aircraft Collision Avoidance Systems."

In these hearings FAA's position was that the primary means of separating air traffic and avoiding in-flight collisions was--and would continue to be for the forseeable future--the air traffic control system. FAA's approach, based on ATCAC's recommendations, was to expand and improve the present system. FAA viewed airborne CAS or other airborne warning devices as backups to ground-based control. Encouraging progress was noted toward a practical and effective airborne CAS for airliners, but major hurdles of cost and complexity seemed, at that time, to stand in the way of developing an airborne CAS or PWI for general aviation.

The Committee on Government Operations issued reports on the Subcommittee hearings, cautioning against blanket acceptance of ATCAC's recommendations as a formal declaration of FAA's research and development program for the next decade. It pointed out that accepting outside recommendations previously resulted in unfortunate cycles of failure and frustration. (See H. Rept. 91-1308, 91st Cong., 2d sess. (1970).)

The Committee also believed that, even with improved equipment and procedures, the air traffic control system was inadequate to meet collision needs. (See H. Rept. 92-919, 92d Cong., 2d sess., (1972) p.3.) It recommended that FAA consider airborne CAS and PWI as inherent elements of the air traffic control system and not merely as backup devices. (See H. Rept. 92-919, p.5.) The collision avoidance problem was recognized as vitally important but one which had no obvious immediate solution that could be authoritatively evaluated. (See H. Rept. 92-919, pp 21 to 24.) Nor was the technical and economic data necessary for evaluating approaches available in FAA since it had no effective program to develop the information, provide for its proper evaluation, and oversee implementation of an overall CAS. (See H. Rept. 92-919, pp. 3 to 5.) Therefore the Subcommittee report called for FAA to organize its research and development program and provide a coordinated approach encompassing all elements of air traffic control.

The Subcommittee on Aeronautics and Space Technology of the House Committee on Science and Astronautics has attempted to highlight the lack of emphasis on aviation safety within Federal agencies. (See H. Rept. 92-1423, pp. 256 to 257). In 1971 correspondence to the Secretary of Transportation, the Committee stated that problems in aviation safety "are not being solved swiftly enough even when solutions are available * * * largely because of the lack of an administrative decision within the government to proceed." Airborne CAS was one of the two examples the Committee used to illustrate this situation.

In hearings on "Collision Avoidance and Pilot Warning Indicator Systems" conducted by the Senate Subcommittee on Aviation of the Committee on Commerce in late 1971 and early 1972 (pp. 205 to 207), FAA reiterated its position favoring upgrading the ground-based air traffic control system to meet midair collision avoidance needs. It believed airborne CAS could have value in expanding collision avoidance capability and as a backup in the event of ground system failures.

The Deputy Administrator of FAA testified that a number of technical, practical, and economic problems remained to be resolved and urged the Subcommittee not to mandate any action calling for nationwide implementation of an airborne system (see "Collision Avoidance and Pilot Warning Indicator Systems," pp. 205 to 207, supra.)

Hearings held by the Senate Commerce Committee, Subcommittee on Aviation, on May 21, 1974, were directed to the status of FAA's evaluation program for CAS alternatives. FAA reported encouraging progress in both airborne and ground-based solution technology.

OWNERS' AND PILOTS' COMMENTS

Generally, owners and pilots associations feel that an airborne collision prevention system is necessary. This is evidenced by the following comments.

Aircraft Owners and Pilots Association

> " * * * We * * * need an airborne solution for * * * the airspace where air traffic control is not provided, as a backup for control failure, and to make possible safe separation of traffic which the present and proposed ground control system cannot accommodate. * * * There just are entirely too many occasions where the ground equipment is not giving us the service."

Air Line Pilots Association

> " * * * ALPA has for many years pressed for action to develop and equip all appropriate aircraft with suitable collision-avoidance devices. * * * For many years, ALPA has urged FAA to 'get control of the aircraft back in the cockpit' instead of it being handled by the [ground] controllers."

Air Transport Association

> " * * * The airlines, will continue, as they have for the past decade, to be the leaders in pressing for the installation of airborne collision avoidance devices, not only in airline aircraft, but all other aircraft that share the airspace."

CHAPTER 4

TECHNOLOGY AND IMPLEMENTATION STATUS

FAA is sponsoring flight tests of three competing airborne CAS, two of which are derived from the Honeywell and McDonnell Douglas operational systems. The testing agency believes that the evaluations may not be completed until late 1975. Considering planned leadtimes for rulemaking and licensing agreements, production units could be available by 1977-78. FAA estimates that 4 years would be needed to equip all aircraft.

The ground-controlled solution, IPC, has yet to be developed and depends on the successful development and deployment of the future air traffic control upgrading, DABS. FAA believes the ground-controlled solution to be at least 2 years behind the airborne solution and it would be 1988 before IPC would be fully implemented; FAA does not now have a formal airborne CAS or IPC implementation goal. Unless DABS-IPC or an airborne solution receives acceptance by the International Civil Aviation Organization, foreign aircraft operating in the United States might not be required by their regulatory bodies to carry such equipment. Therefore, collision protection would be degraded somewhat by these aircraft until the acceptance is obtained, which would take as long as the implementation period for either solution.

AIRBORNE SOLUTIONS--CAS

Several contractors are developing airborne CAS equipment, three of which are being evaluated under FAA sponsorship as possible solutions to the midair collision problem. The pending legislation described in chapter 3 is geared toward selecting one of these airborne CAS techniques as a national standard. The airliner versions have been designed to meet performance requirements in the ATA specification. The equipments designed for general aviation perform the same functions as those for airliners but are less sophisticated.

The table below shows the current status of the major airborne CAS. Appendix I provides (1) operating descriptions for these and other airborne CAS and (2) limited information regarding evaluation programs and costs for those systems not detailed in this chapter.

Equipment	Application	Contractors' estimated selling prices (note a)	Ground stations required	Current testing status	Evaluation completion date (note b)
McDonnell Douglas EROS-II	Airliners	$23,500	[c]Yes	Completed	Sept. 1973
MICRO-CAS	General aviation	2,500	[c]Yes	Completed	Sept. 1973
MINI-CAS	General aviation	Cost figures being derived	[c]Yes	Flight tests to begin in Dec. 1974	July 1975
RCA VECAS (note d)	Airliners	7,000 to 10,000	No	Flight tests completed	Oct. 1974
VECAS-GA	General aviation	1,500	No	Awaiting contract	14 months after contract
Honeywell AVOIDS I (note e)	Airliners	6,000 to 9,000	No	Flight tests completed	Jan. 1975
AVOIDS II	General aviation	[f]1,100	No	Awaiting contract	14 months after contract

[a]This excludes costs for encoding altimeters which would normally be required. The estimated costs for encoding altimeters is $5,300 for airliners and $1,400 for general aviation.

[b]Estimates includes time deemed necessary by the testing agency for data reduction and necessary evaluation.

[c]McDonnell Douglas officials said four stations would provide adequate coverage in the United States and this number was under contract/option in the amount of about $3 million.

[d]Vertical Escape Collision Avoidance System.

[e]Avionic Observation of Intruder Danger Systems.

[f]Only the lowest price claimed by the contractors was verified. After a review of contractor's design approach and preliminary pricing estimates, a manufacturer of general aviation equipment informed us that a "ballpark" price of $1,500 seemed reasonable in mass production.

FAA planned to finish evaluating competitive airborne CAS by the end of 1974. However, completion of these efforts for general aviation versions has been hindered by the lack of timely contracts for these equipments and agreements between FAA and Government testing agencies. FAA now hopes to complete the needed test and evaluation by July 1975. It realizes that this schedule is optimistic and provides little allowance for analysis or report preparation. The contractors told us about 18 months would be needed to deliver production units after selection of a national standard. We believe implementation of an airborne CAS could begin about 1977-78.

Contractors claim that selling prices from $6,000 to $23,500 a unit are achievable for airliner airborne CAS equipment. The cost to equip general aviation has been considered the most critical problem for successful implementation, but a $1,500 unit now seems possible.

Air Force Electronic Systems Division's flight tests of the McDonnell Douglas airborne CAS were conducted in March, 1973; the ARINC Corporation provided planning, laboratory testing, data analysis, and evaluation results. ARINC concluded the time-frequency technique could perform the collision avoidance function accurately and reliably. The airliner version evaluated threats correctly and generated the proper warnings and maneuver commands within necessary time margins. ARINC recommended several minor system modifications to improve the overall operation of the concept but stated that none of these changes was critical. The general aviation equipment lacked a closing speed measurement capability which affected the timeliness of warnings and maneuver commands. ARINC concluded that a CAS lacking closing speed measurement capability should be avoided if at all possible. As a result McDonnell Douglas redesigned its general aviation version and FAA plans to have the National Aviation Facilities Experimental Center test this CAS by mid-1975.

The Naval Air Development Center completed flight tests of RCA's airliner equipment in December 1973. The Navy is evaluating the test data, which will take several months.

Testing personnel said preliminary results of their evaluation show RCA's approach is generally satisfactory. The system provided proper warnings and advisories although some design changes will be needed to improve the timing of maneuver commands. Honeywell's airliner equipment is being tested. Flight tests and evaluations of RCA's and Honeywell's general aviation equipment remain to be performed. According to Navy officials, the earliest date for completion of these tests and evaluations would be mid-1975.

AIRBORNE SOLUTIONS--PWI

There is no pending legislation calling for mandatory PWI equipment or a national standard pertaining to such equipment. However, interest has periodically been kindled by the possibility of such systems providing a low-cost answer to the collision problem. As noted previously, most midair collisions have occurred near airports, in daylight, in clear weather, at low altitudes, and at low closure speeds--conditions when a PWI would seem useful. This conclusion was reached as early as 1969 in a study which called for developing low-cost PWI. These devices have been used successfully by the Army in dense operating areas. Further, a 1973 FAA-sponsored study recommended that PWI be evaluated to see if a low-cost system could be realized to supplement the air traffic control system when ground control is not required or deployed.

In support of FAA's PWI development, the Transportation Systems Center requested proposals for experimental hardware. Contracts totaling about $512,000 were awarded in June 1973 to 4 of 11 companies responding.

The experimental PWI devices were scheduled for delivery about July 1974. The Center, with FAA's National Aviation Facilities Experimental Center, was scheduled to flight-test these prototypes from 4 to 6 months. However, these flight tests have been suspended until testing has been completed on the CAS equipment.

The table below shows contractors' estimated selling prices for the four PWI systems.

Contractor	Estimated selling price
Vega Precision Laboratories	$4,300
Kollsman Instrument Corporation	3,000
Lockheed Aircraft Service Company	3,000
Bendix Corporation, Avionic Division	1,400

Appendix II provides operating descriptions for these and other PWI systems.

COST OF DEVELOPING AIRBORNE TECHNOLOGY

Through fiscal year 1971, the FAA expended about $4 million in the airborne CAS and PWI fields. From that time through fiscal year 1973, another $7 million was funded, and $10 million more is programed through fiscal year 1977. The development costs borne by other Federal agencies will be about $6 million through fiscal year 1975.

Beyond these amounts, the three major airborne CAS contractors have incurred development costs of about $11 million through 1973, much of which has been or will be recovered by overhead charges to Government contracts. Development costs total $39 million.

GROUND-CONTROLLED SOLUTIONS--IPC

FAA's proposed ground-controlled solution is IPC. It is a CAS which can be designed into a future air traffic control upgrading known as DABS. DABS is to provide a two-way electronic link between its new aircraft equipment and improved ground control permitting application of the IPC concept. The IPC logic would supply automatic avoidance commands for aircraft based on computer analysis and resolution of potential collisions indicated by radar/beacon acquired information. FAA estimates that development costs for DABS/IPC will total $40 million.

IPC implementation depends on successful development of DABS. Currently, there is no firm implementation schedule for IPC; however, at best, its deployment could be started concurrently with an initial DABS deployment in 1978. The DABS/IPC ground network of sensors and equipment would not be fully implemented until about 1988.

Ground sites for DABS/IPC would require a significant investment to upgrade present ATCRBS sites, provide new DABS sites, and provide IPC processing capability. The number of ground sites has not been firmly set; FAA officials said it would range between 250 and 350. Preliminary FAA cost estimates to provide DABS/IPC at 300 ground sites total about $190 million.

Due to the early nature of this program, we made no attempt to verify the reasonableness of these estimates. However, we noted concern with the size and cost of data processing equipment projected for the overall system. The $190 million estimate is partly based on using computers which can handle IPC processing for up to 400 aircraft. A current study of DABS accuracy and coverage requirements shows that about 30 proposed sites would face workloads exceeding 400 aircraft and require larger computers.

FAA's estimate of the airborne equipment cost required for DABS/IPC participation is shown below.

User	DABS transponder	Encoding altimeter	IPC display	Total
Airliners	$5,700	$5,300	$1,075	$12,075
General aviation	750	1,400	250	2,400

To expand collision avoidance coverage to airspace beyond that envisioned for IPC, DABS developers have identified two options. One involves expanding IPC through additional ground sites; the other requires developing a new supplemental airborne system known as Synchro-DABS. FAA has no implementation schedule for either option at present; however, an experimental Synchro-DABS equipment evaluation is in progress. Beyond the airborne equipment costs mentioned previously, FAA estimates that Synchro-DABS units would cost about $10,000 for airliners and $2,000 for general aviation aircraft.

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS

CONCLUSIONS

Civil aviation midair collisions continue and are predicted to increase. A catastrophic human and monetary loss could result from a collision between two jumbo airliners. FAA is responsible for promoting and regulating aviation safety. It has been studying the problem for almost two decades, and, although progress has been made in developing technologies for solving the problem, a solution has yet to be implemented.

FAA's progress has, been hindered by changes in its level of interest and funding, differences in technical opinion, a commitment to ground-controlled solutions, and the need for analyzing alternative solutions. Some of these problems are understandable in view of (1) the issue's complexity, (2) the continuing emergence of new technology, (3) the problem's emotional aspects, and (4) the pressures of various groups. However, a CAS and a PWI have been developed and implemented in less than 5 years to satisfy special operational situations.

The Congress has been attempting to accelerate FAA's collision avoidance efforts, primarily in the airborne equipment field. Pending legislation calls for airborne CAS national standards before July 1975 and that airliners be equipped before July 1977. Evaluations of competing equipments have slipped and will not be completed until at least mid-1975. At best, initial production units will not be available before mid-1977. Therefore, target dates in the pending legislation cannot be met.

The airborne CAS evaluation program concentrated on high-performance aircraft systems while the most troublesome problem facing airborne solutions is the development of an effective low-cost general aviation unit. FAA did not include a requirement to test general aviation airborne CAS in its early planning. Testing has concentrated on airliner versions. Delays in contracting for the general aviation equipment and evaluating them have caused the overall CAS evaluation program to slip.

FAA's preferred solution provides new performance capabilities for the air traffic control system by DABS/IPC, and it considers airborne equipment as a possible backup. This approach is being pursued without comprehensive analyses of alternative solutions. Rather, it rests on an advisory committee's 1969 recommendations, which have since been questioned by another independent commission. Both minority positions cited the lack of analyses and justifications in arriving at conclusions and recommendations. FAA has only recently started to compare the costs of independent airborne systems with those of IPC. However, FAA has not decided how many ground sites will be required if the DABS/IPC solution is selected. Therefore, cost figures will vary according to the number of sites finally decided upon.

Because of the human and monetary cost potential of future accidents, the controversy involved, and the large investment necessary to implement any solution, FAA must validate its approach through a comprehensive analysis including a determination of what coverage is required in terms of airspace and types of aircraft, and total costs for implementing each of the alternative solutions, both airborne and ground controlled, to provide the necessary coverage. In the absence of such an analysis, there is no assurance that FAA's approach is the proper one. Further, the solution selected must be revalidated periodically as more information on cost and technical progress is obtained. Without this approach, the midair collision problem and the current controversy will continue.

RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

We recommend that the Secretary of Transportation require and oversee an FAA analysis of all alternative solutions to the midair collision problem. The analysis should be directed toward showing whether a solution is economically feasible, and, if so, which alternative--upgraded ground control with DABS/IPC, airborne CAS or PWI, or combinations of these--offers the best approach. It should address, but not necessarily be limited to, the following issues.

--Defining the airspace which requires coverage and the most cost-effective level of coverage for each alternative.

--Identifying the costs, both public and private, to acquire, implement, operate, and maintain equipment and sites for each alternative.

--Identifying the approaches and cost impact for equipping military aircraft under each alternative since these could collide with civil aircraft.

--Ascertaining the technological status of alternatives based on test results and the time required for full implementation.

--Verifying the technical approaches and proposed selling prices of general aviation airborne CAS units.

--Considering the effect of the energy crisis, environmental restrictions, and economic factors on the predicted growth of general aviation and subsequent impact on air traffic control needs.

We recommend that the best approach subsequently be emphasized and efforts on other alternatives be reduced. The chosen approach should be revalidated periodically as more current information is obtained on cost and technological progress. Further, we recommend that FAA expedite its evaluation program of general aviation airborne CAS units.

AGENCY COMMENTS

The Administrator of FAA agreed fully with the recommendations (see app. III) and stated that:

--The report presents a fair and reasonable assessment of the situation.

--FAA has initiated an in-depth analysis of the alternate solutions to the midair collision problem, and a significant amount of information has been obtained concerning the costs and the potential relative effectiveness of airborne CAS and the ground-based air traffic control system.

--The completed analysis, which will encompass the issues identified in our recommendation, will provide the basis for the FAA-recommended system.

--FAA is proceeding with efforts and a priority consistent with our recommendations.

The Department of Defense and the contractors involved in the program also concurred with the conclusions and recommendations.

MATTER FOR CONSIDERATION BY THE CONGRESS

We are bringing this matter to the attention of the Congress due to the large investment necessary both to the user and the Government to implement any solution and because of the Congress' continuing interest in the midair collision problem. Congressional monitoring may be needed to assure that the best solution, in terms of cost and effectiveness, is selected.

CHAPTER 6

SCOPE OF REVIEW

This study evaluated the midair collision problem and the status of the technologies available and being developed to solve it. Since the thrust of pending legislation is toward implementing an airborne solution for the midair collision problem, our efforts also concerned the possibility of achieving the legislative milestones, if enacted. However, since the ground-based air traffic control system concerns the safe separation of aircraft and therefore presents an alternative to using airborne solutions, we also considered programs which provide new performance capabilities for the system. The study did not address possible impacts, either positive or negative, which could result from changes in regulations and operating procedures, social-environmental considerations, land acquisition programs, or the energy crisis.

We interviewed officials and reviewed records at the following activities.

Federal Government:

Department of Transportation:

Federal Aviation Administration Headquarters, Washington, D.C., and National Aviation Facilities Experimental Center, Atlantic City, N.J.

National Transportation Safety Board, Washington, D.C.

Transportation Systems Center, Cambridge, Mass.

Department of Defense:

Naval Air Development Center, Warminster, Pa.

U.S. Air Force Electronic Systems Division, L. G. Hanscom Field, Bedford, Mass.

U.S. Army Electronics Command, Fort Monmouth, N.J.

Federal Contract Research Center:

Lincoln Laboratory, Lexington, Mass.

Contractors:

ARINC Research Corporation, Annapolis, Md.

Honeywell, Inc., Minneapolis, Minn.

McDonnell Douglas Electronics Company, St. Charles, Mo.

Narco Scientific Industries, Fort Washington, Pa.

RCA Corporation, Moorestown, N.J.

Other organizations:

Aircraft Owners and Pilots Association, Washington, D.C.

Air Line Pilots Association, Washington, D.C.

Air Transport Association, Washington, D.C.

Interdepartmental Group on Collision Avoidance and Pilot Warning, Washington, D.C.

National Air Transportation Conferences, Inc., Washington, D.C.

National Business Aircraft Association, Inc., Washington, D.C.

National Pilots Association, Washington, D.C.

AIRBORNE CAS DESCRIPTIONS

This appendix presents operational descriptions of the major airborne CAS and explains testing programs not discussed in the report. FAA informed us that all systems described require the use of an encoding altimeter, which is assumed to be available on the aircraft.

HONEYWELL AVOIDS

AVOIDS stands for Avionic Observation of Intruder Danger Systems. Aircraft in this cooperative system would require at least a remitter or responder ("here I am" device). A full system must also have a signal processor and cockpit display.

An aircraft electronically interrogates other aircraft. If the intruder is within certain altitude limits, its equipment replies and distance and speed are determined by comparing several samples. This data is used to calculate the time to collision (TAU). Several iterations are compared; if a collision is indicated, an evasion command is generated.

AVOIDS is envisioned as a compatible equipment family for commercial, military, and general aviation. AVOIDS I is designed to ATA operational requirements and is intended for airliners and other high-performance aircraft. AVOIDS II, a less sophisticated system, is intended for general aviation and other low-performance aircraft. A remitter, the lowest cost component, will not provide its user with avoidance data but will furnish such information to aircraft equipped with AVOIDS I or AVOIDS II. These pilots would have to make avoidance maneuvers. Two aircraft with remitters would not be protected from each other.

LITCHFORD SYSTEM

The Air Force Electronics Systems Division is investigating the Litchford concept of airborne equipment listening to other aircraft's ATCRBS transponder replies to ground interrogation. This system was originally conceived as a PWI, but the developer believes the concept can also be used to provide collision prediction and derive avoidance maneuvers.

If an aircraft is nearby, the distance, relative speed, and altitude difference are determined through signal processing and, potentially, direct interrogation. Bearing between aircraft is also measurable. Threat logic would determine any required avoidance maneuvers.

In December 1973 Litchford completed initial design and development effort for the Air Force and sent the results of this 2-year, $150,000 study for FAA evaluation. An Air Force official said Litchford proposed that FAA fund developmental equipment and tests. He estimated 1 year would be required to develop equipment and 6 months for test and evaluation.

MCDONNELL DOUGLAS EROS II AND MICRO CAS

The Eliminate Range Zero System (EROS) is a time-frequency system. Each cooperative unit is precisely time synchronized to all other units by ground stations or other synchronized airborne units.

Time is divided into discrete slots. Each airborne unit selects an empty time slot and transmits information, such as altitude, in that slot. During all other time slots, it "listens" for transmissions from other aircraft. If a received transmission indicates the intruding aircraft is within a prescribed altitude range, distance and relative speed are determined and used to calculate TAU. If, after several iterations, a collision is indicated, an avoidance command is generated.

EROS II, designed to ATA's functional and operational requirements, is intended for airliners and other high-performance aircraft. MICRO-CAS and MINI-CAS, less sophisticated versions are for general aviation and other low-performance aircraft. A low-cost remitter, making aircraft electronically visible to the more sophisticated units is also envisioned. Remitter-equipped aircraft would not be protected from each other.

RCA SECANT

SECANT, an acronym for Separation Control of Aircraft by Nonsynchronous Techniques, is a family of equipments, including a cooperative airborne CAS. SECANT electronically interrogates other aircraft, which respond with data, including altitude. Through several interrogations, if the intruder's altitude is within specified limits, the distance and relative speed are determined and used to calculate TAU. An evasion command is generated if a collision is indicated. Other equipments in the SECANT family include a remitter, an airborne PWI, and a traffic monitoring system.

The equipment tested, VECAS (Vertical Escape CAS), conforms to ATA operational specifications and is intended for airliners and other high-performance aircraft. VECAS-GA is a less sophisticated unit intended for general aviation and other low-performance aircraft. Remitter-equipped aircraft are not protected from each other.

SYNCHRO-DABS

FAA has conceptualized a system known as Synchro-DABS. Various levels of PWI and airborne CAS could operate in the system. A Synchro-DABS aircraft would be protected from all DABS aircraft equipped with encoding altimeters envisioned as mandatory equipment. Without Synchro-DABS, aircraft would not be protected from each other outside the airspace covered by DABS-IPC.

DABS is being designed so that airborne transponder replies can be synchronized by ground interrogations. An aircraft with Synchro-DABS CAS equipment could monitor these replies, using them to predict possible collisions. Avoidance commands would be issued if a collision is indicated. An independent backup mode is also envisioned, which would extend airborne CAS coverage into areas having no ground surveillance through an interrogate-respond technique.

Under Navy contract, the Bendix Corporation is developing equipment for the Naval Weapons Center, China Lake, California. Feasibility flight tests are in progress with the results due about September 1974.

PWI DESCRIPTIONS

This appendix describes the more prominent PWI and explains testing programs not discussed in the report.

BENDIX PWI

The Bendix Corporation's system operates as an ATCRBS listen-in. A protected aircraft's equipment monitors other aircraft replies to ground-controlled interrogations thereby deriving proximity warning capability. The estimated PWI cost is about $1,400. A minimally equipped cooperative user must have an ATCRBS transponder. Without one having a PWI, two ATCRBS equipped aircraft are not protected from each other.

CYGNED PWI

Cygned, Incorporated, developed a noncooperative radar-type PWI. The equipment, costing about $2,000, is designed to detect aircraft within three-quarters of a mile and 1,000 feet above or below the equipped aircraft. Because it is a noncooperative system, the intruding aircraft does not require any special equipment for the PWI to detect its presence. The pilot is warned by a display and buzzer alarm.

HONEYWELL YG-1054 PWI

The Honeywell YG-1054 operates as a cooperative, interrogate-respond system, designed for low-performance helicopters. It warns a pilot whenever an equipped aircraft is within a preselected range and a certain relative altitude. If the pilot cannot see the intruder, an evasive maneuver is possible based on the conveyed relative altitude. With limited order quantities and military specifications, the Army units cost about $3,500 each. Honeywell contends that a similar general aviation PWI built to commercial standards, but with collision threat logic, would cost about $900.

HONEYWELL YG-1081

The Honeywell YG-1081 collision warning device is designed for higher performance aircraft. It and the YG-1054

PWI operate similarly and work cooperatively in the same airspace. Unlike the YG-1054, the YG-1081 issues an alarm only if the intruder is a collision threat. Collision threats are determined using logic similar to an airborne CAS, but, rather than issuing an evasion command, the intruder's location and altitude are displayed to the pilot.

KOLLSMAN PWI

The Kollsman Instrument Corporation PWI is an infrared strobe system, costing about $3,000. Optical sensors aboard protected aircraft detect the near infrared output of anticollision xenon strobe lights aboard other aircraft. Alarm range is influenced by sensor sensitivity, physical environment, and the intruder's strobe light power.

LOCKHEED PWI

The Lockheed Aircraft Service Company PWI is a cooperative radio system. A protected aircraft carries a receiver which detects transmissions of radio beacons aboard intruding aircraft. The protection envelope is determined by the receiver sensitivity and the intruder's beacon power. The protected user estimated cost would be about $3,000, and the cooperative beacon user cost about $750. Two aircraft equipped only with beacons would not be protected from each other.

ROCK PWI

The Rock Avionics Systems, Inc., PWI detects infrared energy emitted by aircraft anticollision strobe lights. Optical sensors are mounted on the protected aircraft's wingtips and/or tail. The detection range is specified as 1.5 miles, which may be manually switched to 0.5 mile to reduce false alarms in high-density terminal areas.

Rock lists the basic system price as $1,495 giving forward and side coverage. An optional tail sensor is available for another $649, providing full coverage.

VEGA PWI

The Vega Precision Laboratories, Inc., system is a cooperative, interrogate-respond PWI. A protected aircraft interrogates and receives answers from intruding aircraft. Protection is 200° forward and 1,000 feet above or below the aircraft. The protected user estimated cost is about $4,300, and the remitter user cost is about $400. Remitter users are not protected from each other.

OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

ASSISTANT SECRETARY
FOR ADMINISTRATION

June 21, 1974

Mr. Henry Eschwege
Director
Resources and Economic Development
Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in response to your letter of May 14, 1974, requesting the Department of Transportation's comments on the General Accounting Office's draft report on aircraft midair collisions.

The report recommends an analysis of all alternative solutions to the midair collision problem, and that the Federal Aviation Administration expedite its evaluation program of general aviation airborne collision avoidance system units. The report presents a fair and reasonable assessment of the situation recognizing that the problem is complex, has been changing, and that there are many factors that must be considered in evaluating the various alternatives and selecting the proposed solution.

The Federal Aviation Administration is proceeding with efforts and a priority consistent with the General Accounting Office recommendations.

I have enclosed two copies of our reply.

Sincerely,

William S. Heffelfinger

William S. Heffelfinger

Enclosure

APPENDIX III

DEPARTMENT OF TRANSPORTATION REPLY

TO

GAO DRAFT REPORT OF MAY 1974

ON

AIRCRAFT MIDAIR COLLISIONS:

A CONTINUING PROBLEM

SUMMARY OF GAO FINDINGS AND RECOMMENDATIONS

Because of continuing Congressional interest and proposed legislation to require the development and use of airborne collision avoidance systems, the GAO performed the review to determine how technological developments were being used by the Federal Aviation Administration (FAA) to solve the problem of midair collisions. The report states that despite improvements in the nation's air traffic control system, the civil aviation midair collision problem still persists. The report points out that FAA has been studying this problem for almost two decades and while progress has been made in the development of technologies and numerous solutions have been proposed, none are yet ready for nationwide implementation. The GAO gives recognition to the fact that FAA efforts have been hindered by differences in technical opinions, changes in the level of interest and funding by the FAA, and FAA's commitment to a ground-controlled system without a comprehensive analysis of alternative solutions. The GAO expresses the opinion that, in view of steps needed in the process of implementing technology, a useful operational solution would not be available for about a decade with several additional years required for complete implementation.

The report also mentions Congressional attempts to accelerate FAA's collision avoidance efforts primarily in the area of an airborne solution, and cites pending legislation which would require national standards for airborne equipment and airliner equipage before July 1975 and July 1977, respectively. The GAO expresses the opinion that under the current FAA program these target dates cannot be met.

In view of the human and monetary cost potential of future accidents, the controversy over which approach is best, and the large user/government investment necessary to implement a solution, the GAO has concluded that FAA must expedite a comprehensive analysis to validate its approach. Accordingly, it has recommended that the Secretary require/oversee an FAA analysis of all alternative solutions to the midair collision problem, with subsequent emphasis being placed on the best approach accompanied by reduced efforts on alternatives with a periodic revalidation of cost data and technological progress. Also, the FAA should expedite its evaluation program of general aviation airborne collision avoidance system units.

SUMMARY OF DEPARTMENT OF TRANSPORTATION POSITION

The GAO draft report presents a fair and reasonable assessment of the situation, recognizing that the problem is complex, has been changing, and that there are many factors that must be considered in evaluating the various alternatives and selecting the proposed solution.

FAA has initiated an in-depth analysis of the alternate solutions to the aircraft midair collision problem, and a significant amount of information has been obtained concerning the costs and the potential relative effectiveness of airborne collision avoidance systems and the ground based air traffic control system. The completed analysis, which will encompass the issues identified in the GAO recommendation, will provide the basis for an FAA-recommended system. All analyses, together with the resulting FAA proposal, will be subject to OST review and approval. In addition, the FAA has signed an interagency agreement with the Naval Air Development Center (NADC) to procure, flight test, and evaluate the general aviation airborne collision avoidance system concepts developed by RCA Corporation and Honeywell, Inc. On May 21 in testimony before the Aviation Subcommittee of the Senate Aviation Committee, the FAA stated that it had scheduled the completion of the analyses and flight tests, cited above, for July 1, 1975.

In summary, the FAA is proceeding with efforts and a priority consistent with the GAO recommendations.

Alexander P. Butterfield
Administrator

PRINCIPAL OFFICIALS OF THE DEPARTMENT OF TRANSPORTATION RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of Office From	To
DEPARTMENT OF TRANSPORTATION		
SECRETARY OF TRANSPORTATION:		
Claude S. Brinegar	Feb. 1973	Present
John A. Volpe	Jan. 1969	Feb. 1973
Alan S. Boyd	Jan. 1967	Dec. 1968
FEDERAL AVIATION ADMINISTRATION		
ADMINISTRATOR:		
Alexander P. Butterfield	Mar. 1973	Present
John H. Shaffer	Mar. 1969	Mar. 1973
David D. Thomas (acting)	Aug. 1968	Mar. 1969
Gen. William F. McKee	July 1965	July 1968
Najeeb E. Halaby	Feb. 1961	July 1965

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